

**Environmental Protection Agency**

**Pt. 50, App. O**

Where:

$d_{High}$  = number of calendar days in the “High” season;

$d_{Low}$  = number of calendar days in the “Low” season;

$d_{High} + d_{Low}$  = days in a year; and

$$F_a(x) = \frac{\text{number of daily values in season a that are } \leq x}{\text{number of daily values in season a}}$$

Such that “a” can be either “High” or “Low”; “x” is the measured concentration; and “ $d_{High}/(d_{High} + d_{Low})$  and  $d_{Low}/(d_{High} + d_{Low})$ ” are constant and are called seasonal “weights.”

(b) The 24-hour standard design value is then calculated by averaging the annual 98th percentiles using equation 6 of this appendix:

*Equation 6*

$$P_{0.98} = \frac{\sum_{y=1}^3 P_{0.98,y}}{3}$$

(c) The 24-hour standard design value (3-year average 98th percentile) is rounded according to the conventions in section 4.3 of this appendix before a comparison with the standard is made.

[71 FR 61227, Oct. 17, 2006, as amended at 73 FR 1502, Jan. 9, 2008]

**APPENDIX O TO PART 50—REFERENCE METHOD FOR THE DETERMINATION OF COARSE PARTICULATE MATTER AS PM<sub>10-2.5</sub> IN THE ATMOSPHERE**

*1.0 Applicability and Definition*

1.1 This method provides for the measurement of the mass concentration of coarse particulate matter (PM<sub>10-2.5</sub>) in ambient air over a 24-hour period. In conjunction with additional analysis, this method may be used to develop speciated data.

1.2 For the purpose of this method, PM<sub>10-2.5</sub> is defined as particulate matter having an aerodynamic diameter in the nominal range of 2.5 to 10 micrometers, inclusive.

1.3 For this reference method, PM<sub>10-2.5</sub> concentrations shall be measured as the arithmetic difference between separate but concurrent, collocated measurements of PM<sub>10</sub> and PM<sub>2.5</sub>, where the PM<sub>10</sub> measurements are obtained with a specially approved sampler, identified as a “PM<sub>10c</sub> sampler,” that meets more demanding performance requirements than conventional PM<sub>10</sub> samplers described in appendix J of this part. Measurements obtained with a PM<sub>10c</sub> sampler are identified as “PM<sub>10c</sub> measurements” to distinguish them from conventional PM<sub>10</sub> meas-

urements obtained with conventional PM<sub>10</sub> samplers. Thus, PM<sub>10-2.5</sub> = PM<sub>10c</sub> - PM<sub>2.5</sub>.

1.4 The PM<sub>10c</sub> and PM<sub>2.5</sub> gravimetric measurement processes are considered to be non-destructive, and the PM<sub>10c</sub> and PM<sub>2.5</sub> samples obtained in the PM<sub>10-2.5</sub> measurement process can be subjected to subsequent physical or chemical analyses.

1.5 Quality assessment procedures are provided in part 58, appendix A of this chapter. The quality assurance procedures and guidance provided in reference 1 in section 13 of this appendix, although written specifically for PM<sub>2.5</sub>, are generally applicable for PM<sub>10c</sub>, and, hence, PM<sub>10-2.5</sub> measurements under this method, as well.

1.6 A method based on specific model PM<sub>10c</sub> and PM<sub>2.5</sub> samplers will be considered a reference method for purposes of part 58 of this chapter only if:

(a) The PM<sub>10c</sub> and PM<sub>2.5</sub> samplers and the associated operational procedures meet the requirements specified in this appendix and all applicable requirements in part 53 of this chapter, and

(b) The method based on the specific samplers and associated operational procedures have been designated as a reference method in accordance with part 53 of this chapter.

1.7 PM<sub>10-2.5</sub> methods based on samplers that meet nearly all specifications set forth in this method but have one or more significant but minor deviations or modifications from those specifications may be designated as “Class I” equivalent methods for PM<sub>10-2.5</sub> in accordance with part 53 of this chapter.

1.8 PM<sub>2.5</sub> measurements obtained incidental to the PM<sub>10-2.5</sub> measurements by this method shall be considered to have been obtained with a reference method for PM<sub>2.5</sub> in accordance with appendix L of this part.

1.9 PM<sub>10c</sub> measurements obtained incidental to the PM<sub>10-2.5</sub> measurements by this method shall be considered to have been obtained with a reference method for PM<sub>10</sub> in accordance with appendix J of this part, provided that:

(a) The PM<sub>10c</sub> measurements are adjusted to EPA reference conditions (25 °C and 760 millimeters of mercury), and

(b) Such PM<sub>10c</sub> measurements are appropriately identified to differentiate them from PM<sub>10</sub> measurements obtained with other (conventional) methods for PM<sub>10</sub> designated in accordance with part 53 of this

chapter as reference or equivalent methods for PM<sub>10</sub>.

### 2.0 Principle

2.1 Separate, collocated, electrically powered air samplers for PM<sub>10c</sub> and PM<sub>2.5</sub> concurrently draw ambient air at identical, constant volumetric flow rates into specially shaped inlets and through one or more inertial particle size separators where the suspended particulate matter in the PM<sub>10</sub> or PM<sub>2.5</sub> size range, as applicable, is separated for collection on a polytetrafluoroethylene (PTFE) filter over the specified sampling period. The air samplers and other aspects of this PM<sub>10-2.5</sub> reference method are specified either explicitly in this appendix or by reference to other applicable regulations or quality assurance guidance.

2.2 Each PM<sub>10c</sub> and PM<sub>2.5</sub> sample collection filter is weighed (after moisture and temperature conditioning) before and after sample collection to determine the net weight (mass) gain due to collected PM<sub>10c</sub> or PM<sub>2.5</sub>. The total volume of air sampled by each sampler is determined by the sampler from the measured flow rate at local ambient temperature and pressure and the sampling time. The mass concentrations of both PM<sub>10c</sub> and PM<sub>2.5</sub> in the ambient air are computed as the total mass of collected particles in the PM<sub>10</sub> or PM<sub>2.5</sub> size range, as appropriate, divided by the total volume of air sampled by the respective samplers, and expressed in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) at local temperature and pressure conditions. The mass concentration of PM<sub>10-2.5</sub> is determined as the PM<sub>10c</sub> concentration value less the corresponding, concurrently measured PM<sub>2.5</sub> concentration value.

2.3 Most requirements for PM<sub>10-2.5</sub> reference methods are similar or identical to the requirements for PM<sub>2.5</sub> reference methods as set forth in appendix L to this part. To insure uniformity, applicable appendix L requirements are incorporated herein by reference in the sections where indicated rather than repeated in this appendix.

### 3.0 PM<sub>10-2.5</sub> Measurement Range

3.1 *Lower concentration limit.* The lower detection limit of the mass concentration measurement range is estimated to be approximately  $3 \mu\text{g}/\text{m}^3$ , based on the observed precision of PM<sub>2.5</sub> measurements in the national PM<sub>2.5</sub> monitoring network, the probable similar level of precision for the matched PM<sub>10c</sub> measurements, and the additional variability arising from the differential nature of the measurement process. This value is provided merely as a guide to the significance of low PM<sub>10-2.5</sub> concentration measurements.

3.2 *Upper concentration limit.* The upper limit of the mass concentration range is determined principally by the PM<sub>10c</sub> filter mass

loading beyond which the sampler can no longer maintain the operating flow rate within specified limits due to increased pressure drop across the loaded filter. This upper limit cannot be specified precisely because it is a complex function of the ambient particle size distribution and type, humidity, the individual filter used, the capacity of the sampler flow rate control system, and perhaps other factors. All PM<sub>10c</sub> samplers are estimated to be capable of measuring 24-hour mass concentrations of at least  $200 \mu\text{g}/\text{m}^3$  while maintaining the operating flow rate within the specified limits. The upper limit for the PM<sub>10-2.5</sub> measurement is likely to be somewhat lower because the PM<sub>10-2.5</sub> concentration represents only a fraction of the PM<sub>10</sub> concentration.

3.3 *Sample period.* The required sample period for PM<sub>10-2.5</sub> concentration measurements by this method shall be at least 1,380 minutes but not more than 1,500 minutes (23 to 25 hours), and the start times of the PM<sub>2.5</sub> and PM<sub>10c</sub> samples are within 10 minutes and the stop times of the samples are also within 10 minutes (see section 10.4 of this appendix).

### 4.0 Accuracy (bias)

4.1 Because the size, density, and volatility of the particles making up ambient particulate matter vary over wide ranges and the mass concentration of particles varies with particle size, it is difficult to define the accuracy of PM<sub>10-2.5</sub> measurements in an absolute sense. Furthermore, generation of credible PM<sub>10-2.5</sub> concentration standards at field monitoring sites and presenting or introducing such standards reliably to samplers or monitors to assess accuracy is still generally impractical. The accuracy of PM<sub>10-2.5</sub> measurements is therefore defined in a relative sense as bias, referenced to measurements provided by other reference method samplers or based on flow rate verification audits or checks, or on other performance evaluation procedures.

4.2 Measurement system bias for monitoring data is assessed according to the procedures and schedule set forth in part 58, appendix A of this chapter. The goal for the measurement uncertainty (as bias) for monitoring data is defined in part 58, appendix A of this chapter as an upper 95 percent confidence limit for the absolute bias of 15 percent. Reference 1 in section 13 of this appendix provides additional information and guidance on flow rate accuracy audits and assessment of bias.

### 5.0 Precision

5.1 Tests to establish initial measurement precision for each sampler of the reference method sampler pair are specified as a part of the requirements for designation as a reference method under part 53 of this chapter.

5.2 Measurement system precision is assessed according to the procedures and schedule set forth in appendix A to part 58 of this chapter. The goal for acceptable measurement uncertainty, as precision, of monitoring data is defined in part 58, appendix A of this chapter as an upper 95 percent confidence limit for the coefficient of variation (CV) of 15 percent. Reference 1 in section 13 of this appendix provides additional information and guidance on this requirement.

6.0 *Filters for PM<sub>10c</sub> and PM<sub>2.5</sub> Sample Collection.* Sample collection filters for both PM<sub>10c</sub> and PM<sub>2.5</sub> measurements shall be identical and as specified in section 6 of appendix L to this part.

7.0 *Sampler.* The PM<sub>10-2.5</sub> sampler shall consist of a PM<sub>10c</sub> sampler and a PM<sub>2.5</sub> sampler, as follows:

7.1 The PM<sub>2.5</sub> sampler shall be as specified in section 7 of appendix L to this part.

7.2 The PM<sub>10c</sub> sampler shall be of like manufacturer, design, configuration, and fabrication to that of the PM<sub>2.5</sub> sampler and as specified in section 7 of appendix L to this part, except as follows:

7.2.1 The particle size separator specified in section 7.3.4 of appendix L to this part shall be eliminated and replaced by a downtube extension fabricated as specified in Figure O-1 of this appendix.

7.2.2 The sampler shall be identified as a PM<sub>10c</sub> sampler on its identification label required under §53.9(d) of this chapter.

7.2.3 The average temperature and average barometric pressure measured by the sampler during the sample period, as described in Table L-1 of appendix L to this part, need not be reported to EPA's AQS data base, as required by section 7.4.19 and Table L-1 of appendix L to this part, provided such measurements for the sample period determined by the associated PM<sub>2.5</sub> sampler are reported as required.

7.3 In addition to the operation/instruction manual required by section 7.4.18 of appendix L to this part for each sampler, supplemental operational instructions shall be provided for the simultaneous operation of the samplers as a pair to collect concurrent PM<sub>10c</sub> and PM<sub>2.5</sub> samples. The supplemental instructions shall cover any special procedures or guidance for installation and setup of the samplers for PM<sub>10-2.5</sub> measurements, such as synchronization of the samplers' clocks or timers, proper programming for collection of concurrent samples, and any other pertinent issues related to the simultaneous, coordinated operation of the two samplers.

7.4 Capability for electrical interconnection of the samplers to simplify sample period programming and further ensure simultaneous operation is encouraged but not required. Any such capability for interconnection shall not supplant each sampler's capa-

bility to operate independently, as required by section 7 of appendix L of this part.

#### 8.0 *Filter Weighing*

8.1 Conditioning and weighing for both PM<sub>10c</sub> and PM<sub>2.5</sub> sample filters shall be as specified in section 8 of appendix L to this part. See reference 1 of section 13 of this appendix for additional, more detailed guidance.

8.2 Handling, conditioning, and weighing for both PM<sub>10c</sub> and PM<sub>2.5</sub> sample filters shall be matched such that the corresponding PM<sub>10c</sub> and PM<sub>2.5</sub> filters of each filter pair receive uniform treatment. The PM<sub>10c</sub> and PM<sub>2.5</sub> sample filters should be weighed on the same balance, preferably in the same weighing session and by the same analyst.

8.3 Due care shall be exercised to accurately maintain the paired relationship of each set of concurrently collected PM<sub>10c</sub> and PM<sub>2.5</sub> sample filters and their net weight gain data and to avoid misidentification or reversal of the filter samples or weight data. See Reference 1 of section 13 of this appendix for additional guidance.

9.0 *Calibration.* Calibration of the flow rate, temperature measurement, and pressure measurement systems for both the PM<sub>10c</sub> and PM<sub>2.5</sub> samplers shall be as specified in section 9 of appendix L to this part.

#### 10.0 *PM<sub>10-2.5</sub> Measurement Procedure*

10.1 The PM<sub>10c</sub> and PM<sub>2.5</sub> samplers shall be installed at the monitoring site such that their ambient air inlets differ in vertical height by not more than 0.2 meter, if possible, but in any case not more than 1 meter, and the vertical axes of their inlets are separated by at least 1 meter but not more than 4 meters, horizontally.

10.2 The measurement procedure for PM<sub>10c</sub> shall be as specified in section 10 of appendix L to this part, with "PM<sub>10c</sub>" substituted for "PM<sub>2.5</sub>" wherever it occurs in that section.

10.3 The measurement procedure for PM<sub>2.5</sub> shall be as specified in section 10 of appendix L to this part.

10.4 For the PM<sub>10-2.5</sub> measurement, the PM<sub>10c</sub> and PM<sub>2.5</sub> samplers shall be programmed to operate on the same schedule and such that the sample period start times are within 5 minutes and the sample duration times are within 5 minutes.

10.5 Retrieval, transport, and storage of each PM<sub>10c</sub> and PM<sub>2.5</sub> sample pair following sample collection shall be matched to the extent practical such that both samples experience uniform conditions.

11.0 *Sampler Maintenance.* Both PM<sub>10c</sub> and PM<sub>2.5</sub> samplers shall be maintained as described in section 11 of appendix L to this part.

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*12.0 Calculations*

12.1 Both concurrent  $PM_{10c}$  and  $PM_{2.5}$  measurements must be available, valid, and meet the conditions of section 10.4 of this appendix to determine the  $PM_{10-2.5}$  mass concentration.

12.2 The  $PM_{10c}$  mass concentration is calculated using equation 1 of this section:

*Equation 1*

$$PM_{10c} = \frac{(W_f - W_i)}{V_a}$$

Where:

$PM_{10c}$  = mass concentration of  $PM_{10c}$ ,  $\mu\text{g}/\text{m}^3$ ;  
 $W_f$ ,  $W_i$  = final and initial masses (weights), respectively, of the filter used to collect the  $PM_{10c}$  particle sample,  $\mu\text{g}$ ;

$V_a$  = total air volume sampled by the  $PM_{10c}$  sampler in actual volume units measured at local conditions of temperature and pressure, as provided by the sampler,  $\text{m}^3$ .

NOTE: Total sample time must be between 1,380 and 1,500 minutes (23 and 25 hrs) for a

fully valid  $PM_{10c}$  sample; however, see also section 3.3 of this appendix.

12.3 The  $PM_{2.5}$  mass concentration is calculated as specified in section 12 of appendix L to this part.

12.4 The  $PM_{10-2.5}$  mass concentration, in  $\mu\text{g}/\text{m}^3$ , is calculated using Equation 2 of this section:

*Equation 2*

$$PM_{10-2.5} = PM_{10c} - PM_{2.5}$$

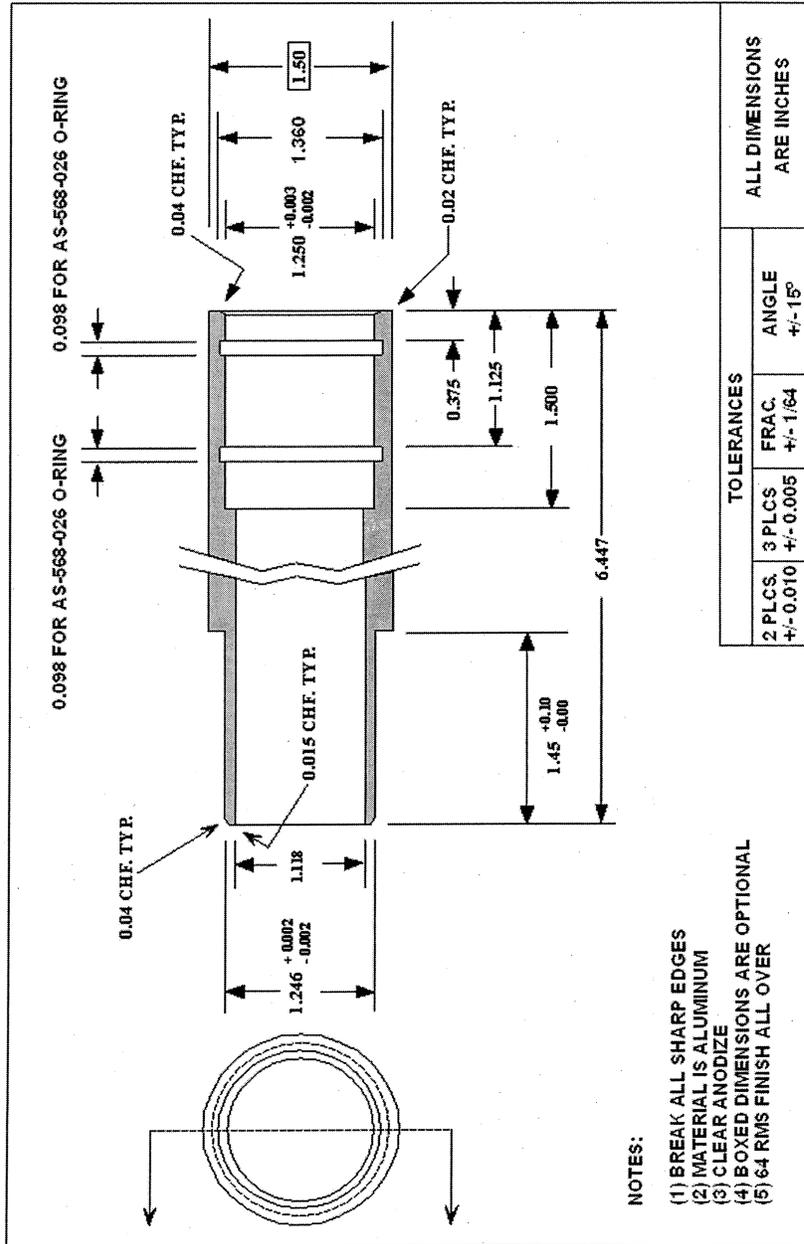
*13.0 Reference*

1. Quality Assurance Guidance Document 2.12. Monitoring  $PM_{2.5}$  in Ambient Air Using Designated Reference or Class I Equivalent Methods. Draft, November 1998 (or later version or supplement, if available). Available at: [www.epa.gov/ttn/amtic/pgqa.html](http://www.epa.gov/ttn/amtic/pgqa.html).

*14.0 Figures*

Figure O-1 is included as part of this appendix O.

FIGURE O-1. DOWNTUBE EXTENSION



[71 FR 61230, Oct. 17, 2006]

APPENDIX P TO PART 50—INTERPRETATION OF THE PRIMARY AND SECONDARY NATIONAL AMBIENT AIR QUALITY STANDARDS FOR OZONE

1. General

(a) This appendix explains the data handling conventions and computations necessary for determining whether the national 8-hour primary and secondary ambient air quality standards for ozone (O<sub>3</sub>) specified in §50.15 are met at an ambient O<sub>3</sub> air quality monitoring site. Ozone is measured in the ambient air by a reference method based on appendix D of this part, as applicable, and designated in accordance with part 53 of this chapter, or by an equivalent method designated in accordance with part 53 of this chapter. Data reporting, data handling, and computation procedures to be used in making comparisons between reported O<sub>3</sub> concentrations and the levels of the O<sub>3</sub> standards are specified in the following sections. Whether to exclude, retain, or make adjustments to the data affected by exceptional events, including stratospheric O<sub>3</sub> intrusion and other natural events, is determined by the requirements under §§50.1, 50.14 and 51.930.

(b) The terms used in this appendix are defined as follows:

*8-hour average* is the rolling average of eight hourly O<sub>3</sub> concentrations as explained in section 2 of this appendix.

*Annual fourth-highest daily maximum* refers to the fourth highest value measured at a monitoring site during a particular year.

*Daily maximum 8-hour average concentration* refers to the maximum calculated 8-hour average for a particular day as explained in section 2 of this appendix.

*Design values* are the metrics (*i.e.*, statistics) that are compared to the NAAQS levels to determine compliance, calculated as shown in section 3 of this appendix.

*O<sub>3</sub> monitoring season* refers to the span of time within a calendar year when individual States are required to measure ambient O<sub>3</sub> concentrations as listed in part 58 appendix D to this chapter.

*Year* refers to calendar year.

2. Primary and Secondary Ambient Air Quality Standards for Ozone

2.1 Data Reporting and Handling Conventions

*Computing 8-hour averages.* Hourly average concentrations shall be reported in parts per million (ppm) to the third decimal place, with additional digits to the right of the third decimal place truncated. Running 8-hour averages shall be computed from the hourly O<sub>3</sub> concentration data for each hour

of the year and shall be stored in the first, or start, hour of the 8-hour period. An 8-hour average shall be considered valid if at least 75% of the hourly averages for the 8-hour period are available. In the event that only 6 or 7 hourly averages are available, the 8-hour average shall be computed on the basis of the hours available using 6 or 7 as the divisor. 8-hour periods with three or more missing hours shall be considered valid also, if, after substituting one-half the minimum detectable limit for the missing hourly concentrations, the 8-hour average concentration is greater than the level of the standard. The computed 8-hour average O<sub>3</sub> concentrations shall be reported to three decimal places (the digits to the right of the third decimal place are truncated, consistent with the data handling procedures for the reported data).

*Daily maximum 8-hour average concentrations.* (a) There are 24 possible running 8-hour average O<sub>3</sub> concentrations for each calendar day during the O<sub>3</sub> monitoring season. The daily maximum 8-hour concentration for a given calendar day is the highest of the 24 possible 8-hour average concentrations computed for that day. This process is repeated, yielding a daily maximum 8-hour average O<sub>3</sub> concentration for each calendar day with ambient O<sub>3</sub> monitoring data. Because the 8-hour averages are recorded in the start hour, the daily maximum 8-hour concentrations from two consecutive days may have some hourly concentrations in common. Generally, overlapping daily maximum 8-hour averages are not likely, except in those non-urban monitoring locations with less pronounced diurnal variation in hourly concentrations.

(b) An O<sub>3</sub> monitoring day shall be counted as a valid day if valid 8-hour averages are available for at least 75% of possible hours in the day (*i.e.*, at least 18 of the 24 averages). In the event that less than 75% of the 8-hour averages are available, a day shall also be counted as a valid day if the daily maximum 8-hour average concentration for that day is greater than the level of the standard.

2.2 Primary and Secondary Standard-related Summary Statistic

The standard-related summary statistic is the annual fourth-highest daily maximum 8-hour O<sub>3</sub> concentration, expressed in parts per million, averaged over three years. The 3-year average shall be computed using the three most recent, consecutive calendar years of monitoring data meeting the data completeness requirements described in this appendix. The computed 3-year average of the annual fourth-highest daily maximum 8-hour average O<sub>3</sub> concentrations shall be reported to three decimal places (the digits to the right of the third decimal place are truncated, consistent with the data handling procedures for the reported data).